UCSD

Structure, Dynamics, and Viscoelasticity of Nanoparticle Thin Films at the Liquid-Air Interface

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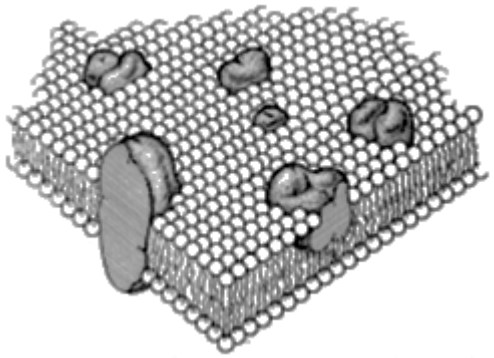
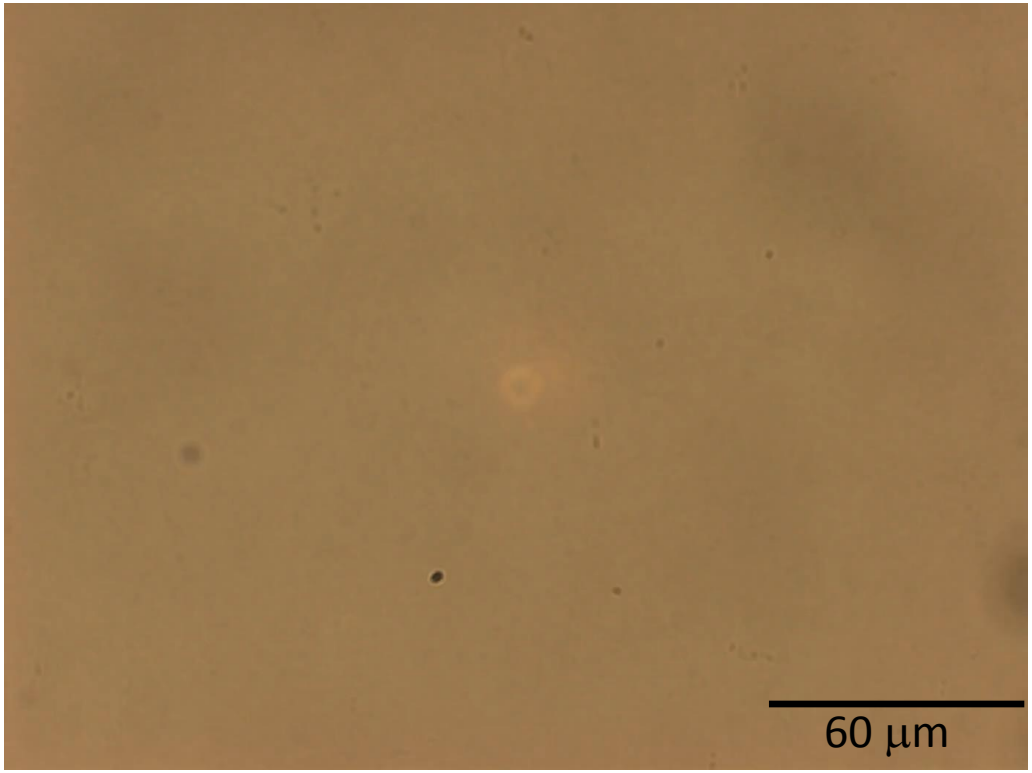
National Science Foundation
WHERE DISCOVERIES BEGIN

Thin Films

- Antireflective optical coatings
- Flexible electronics
- Biomembranes

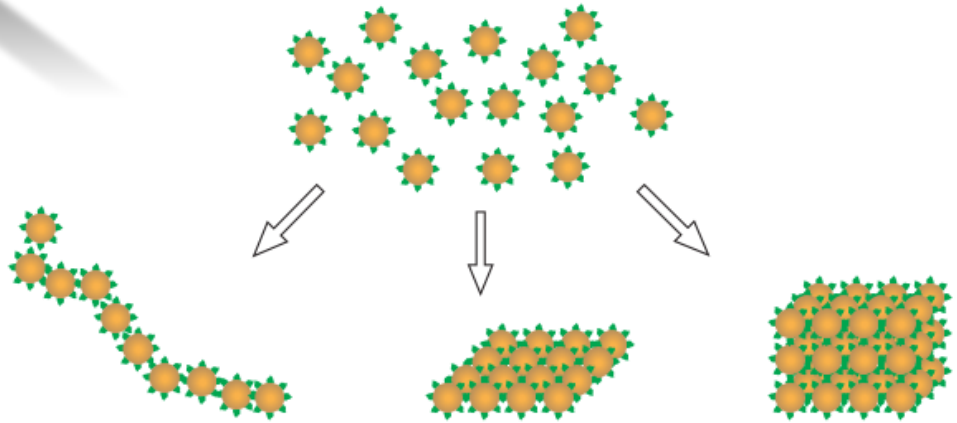


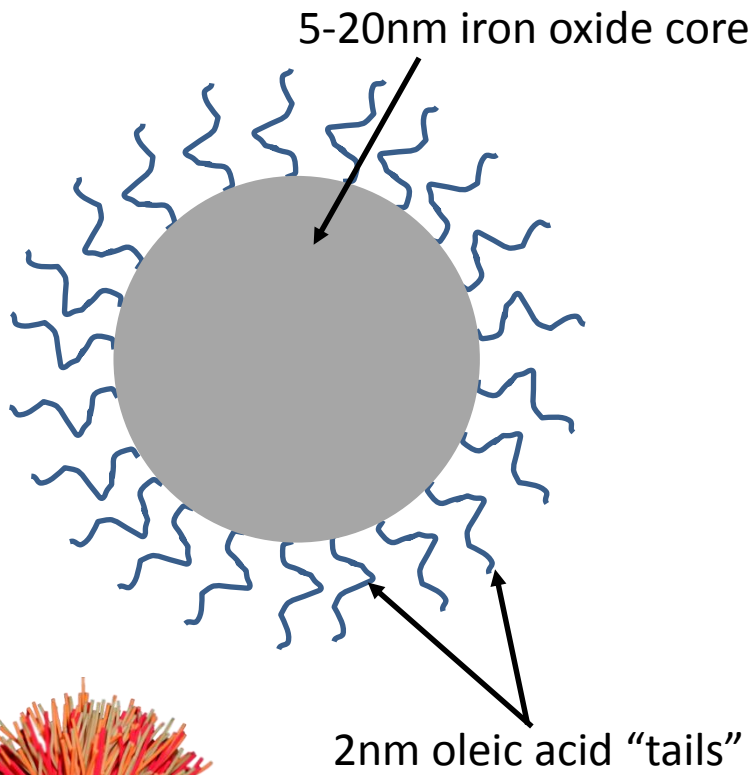
10nm iron oxide nanoparticle film during compression on liquid surface



Singer, S. J., & Nicolson, G. L. (1972). *Science*, *175*(23)

Liquid Surface Self Assembly

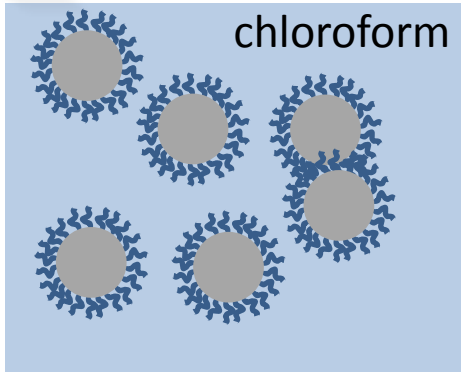


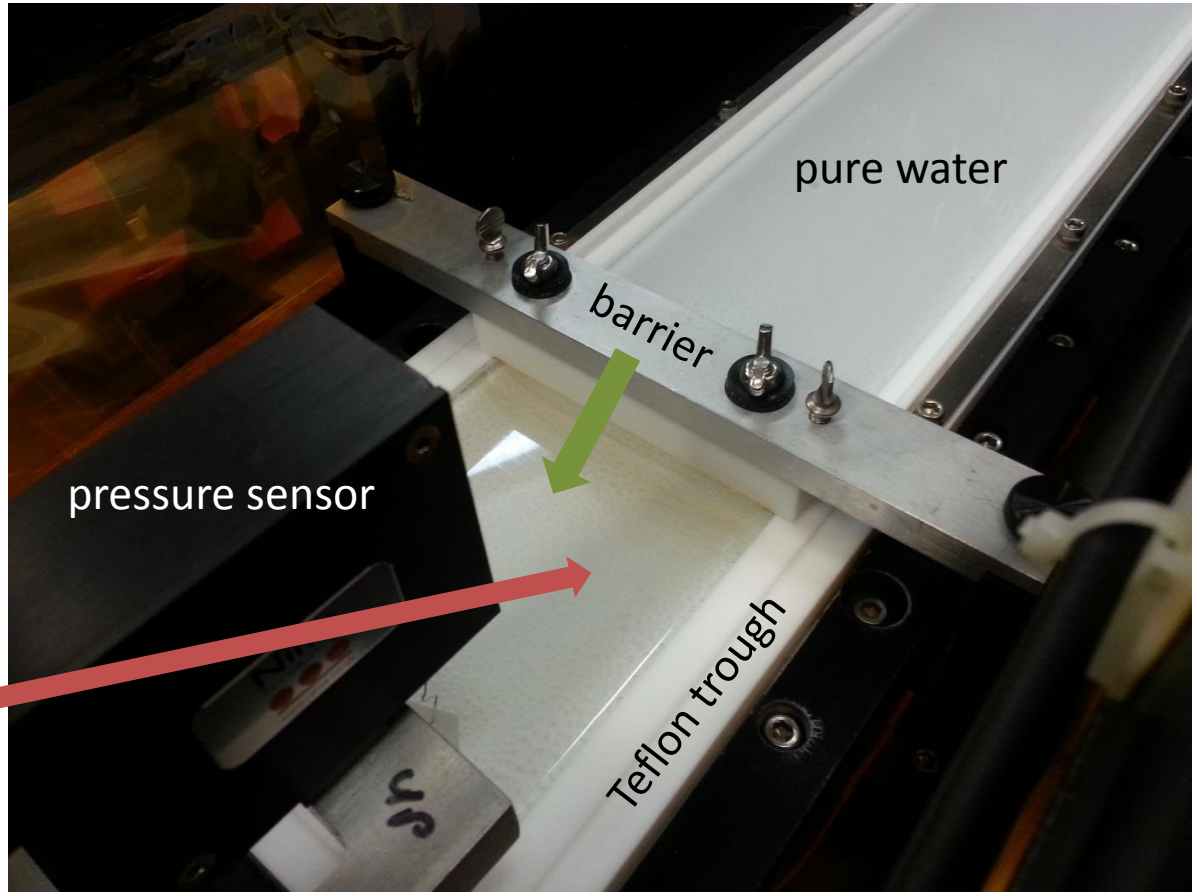


- Van der Waals Force
- Interfacial Forces
- Magnetic Interactions
- Electric Interactions

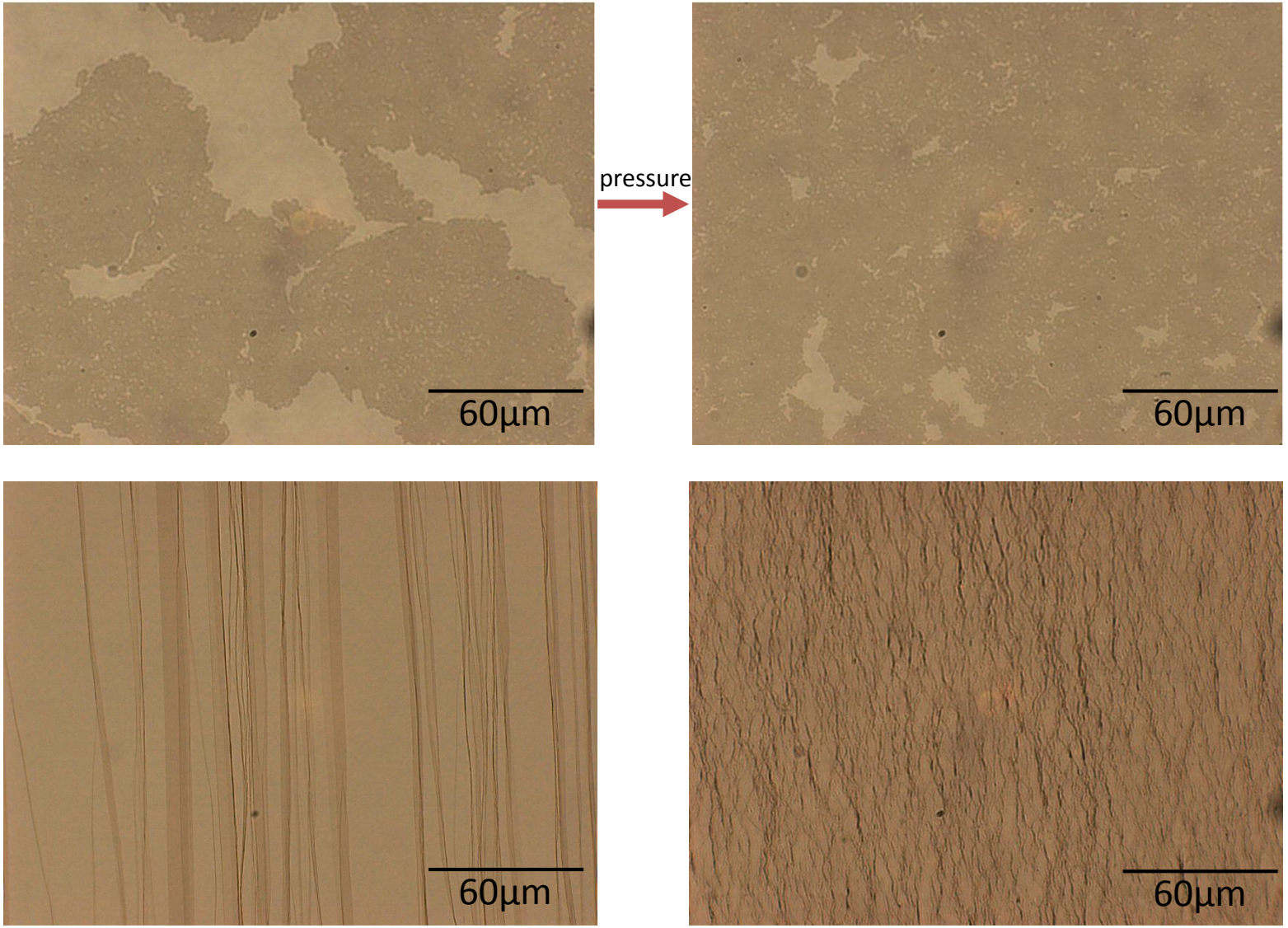
Nie, Z., Petukhova, A., & Kumacheva, E. (2010). *Nature nanotechnology*, *5*(1)

Langmuir-Blodgett Trough

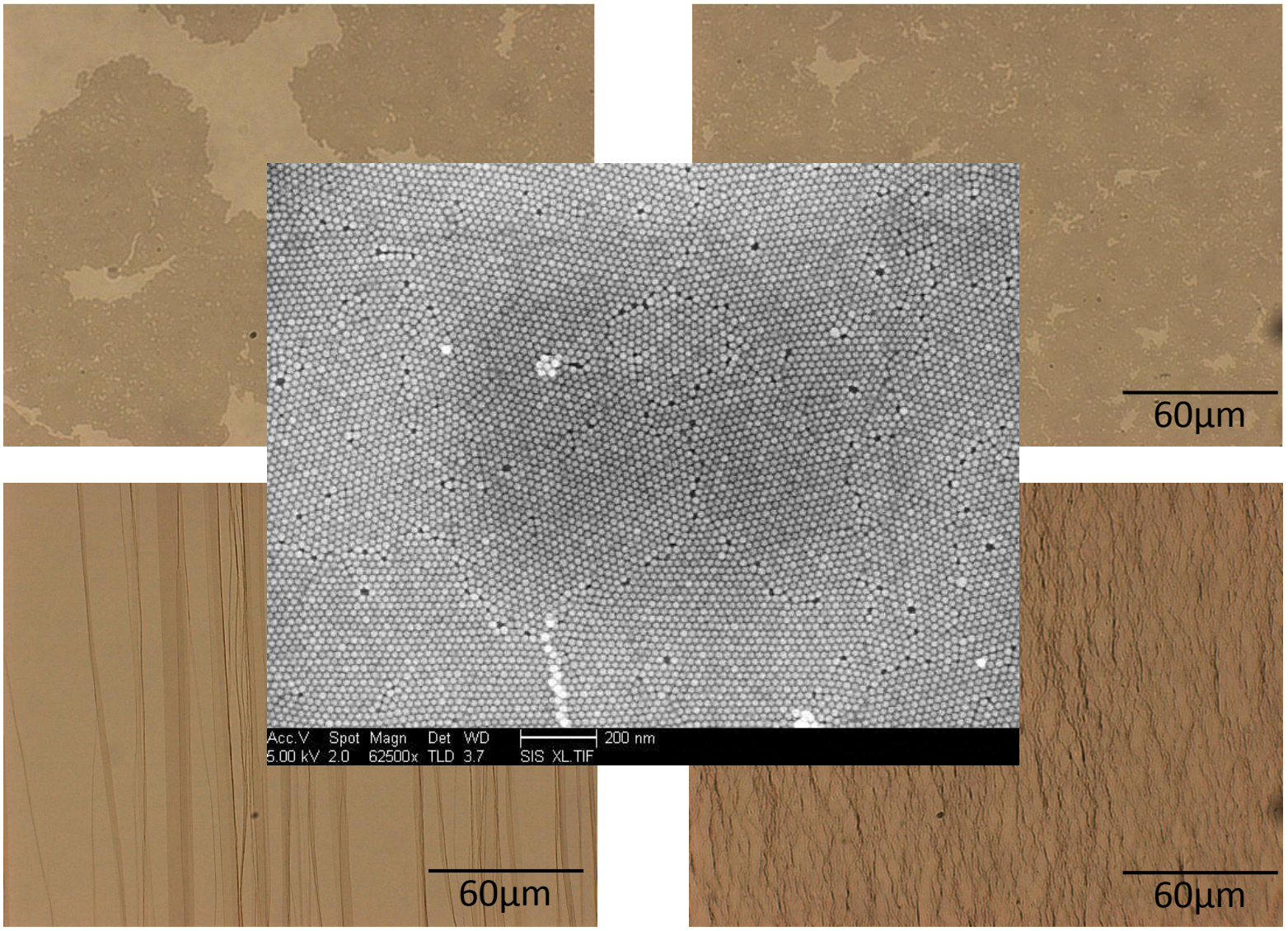




The Macroscopic Picture



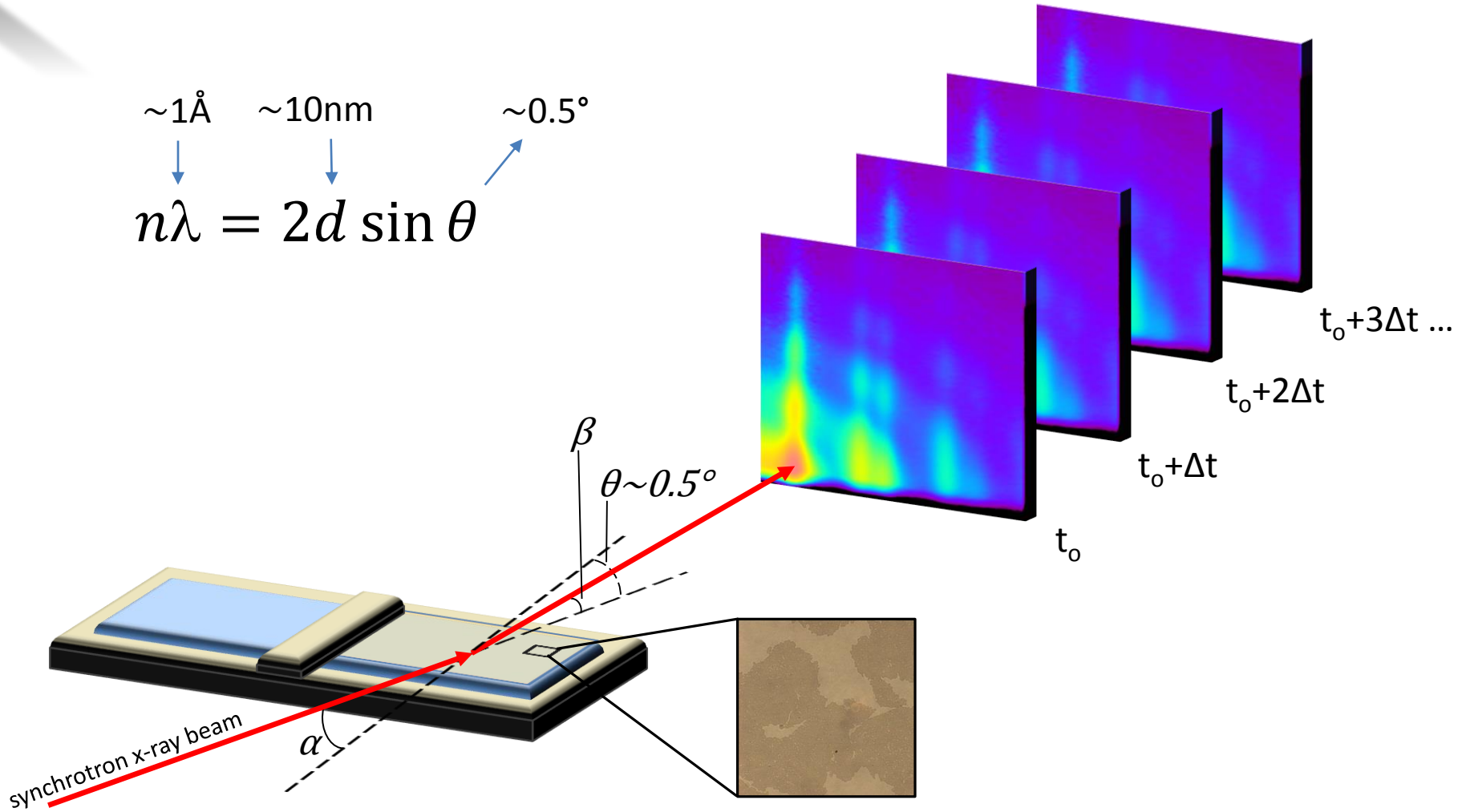
The Microscopic Picture



Grazing Incidence Diffraction (GID)
X-Ray Photon Correlation Spectroscopy (XPCS)

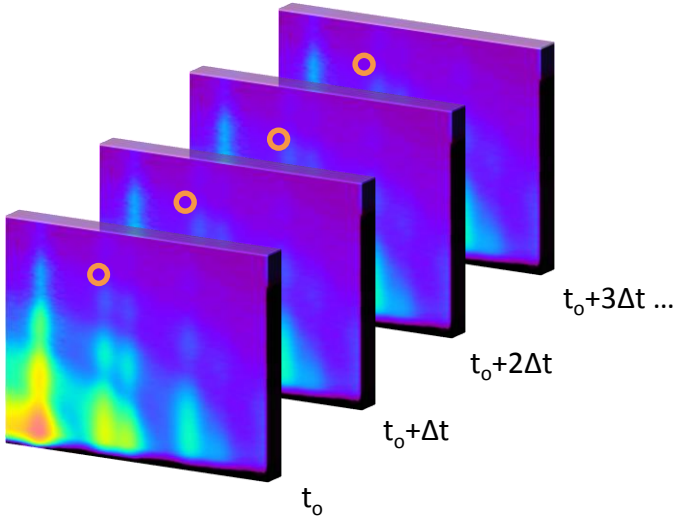
~1Å ~10nm ~0.5°

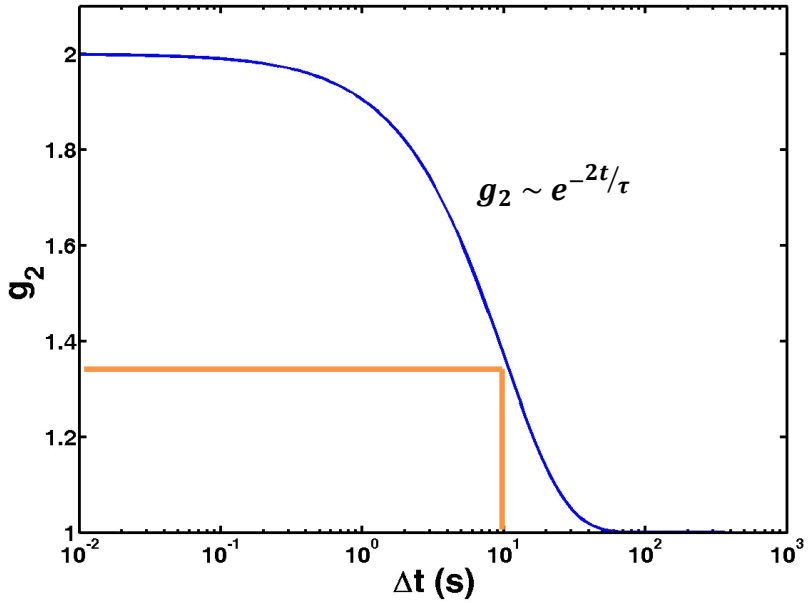
$$n\lambda = 2d \sin\theta$$

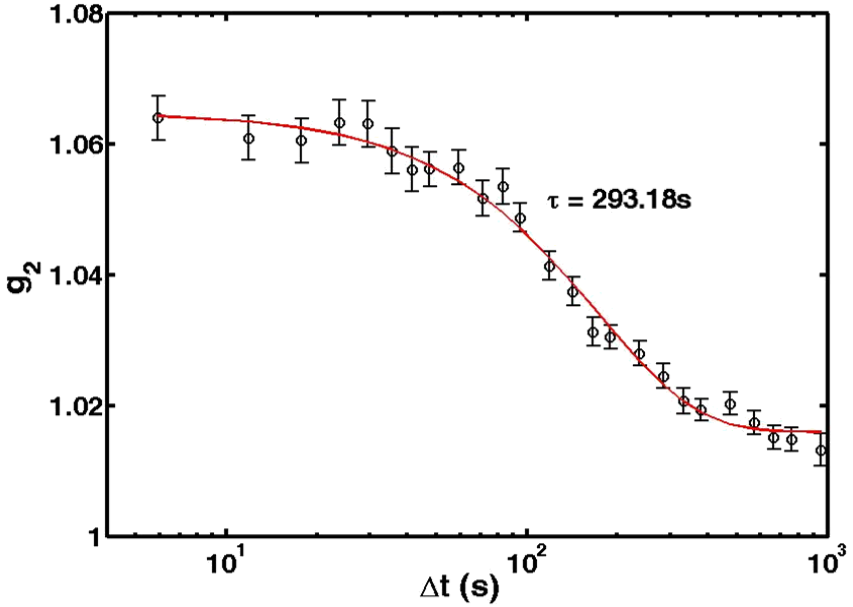


Interparticle Dynamics

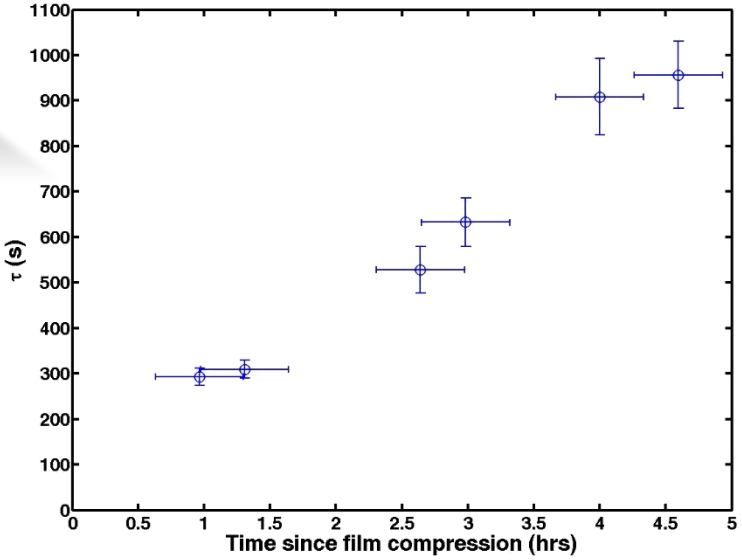
$$g_2(\Delta t) = \frac{\langle I(t)I(t+\Delta t)\rangle_t}{\langle I(t)\rangle_t^{\,2}}$$

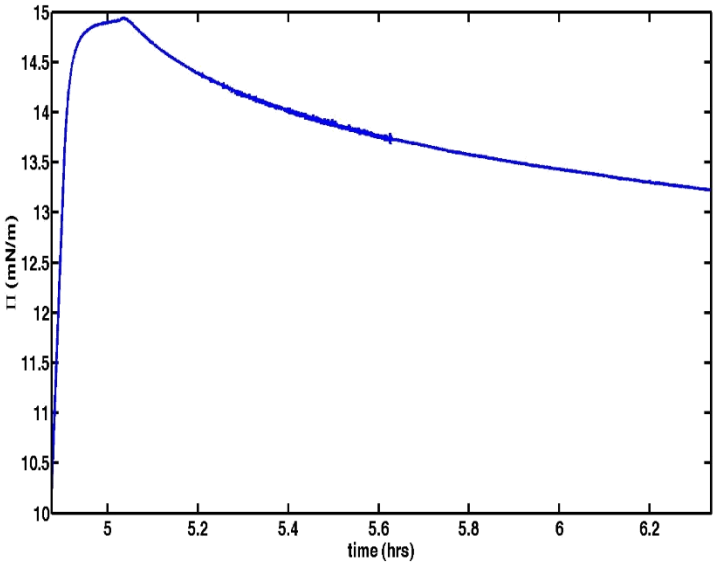


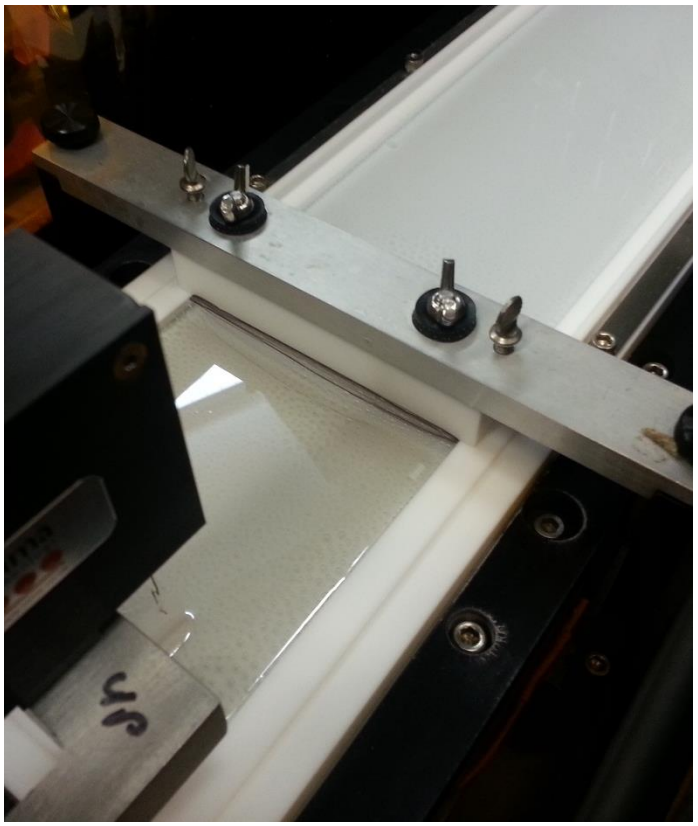




Viscoelasticity

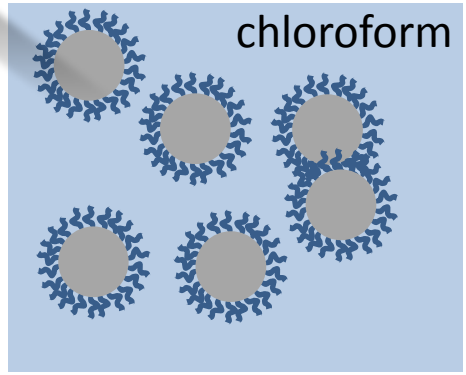


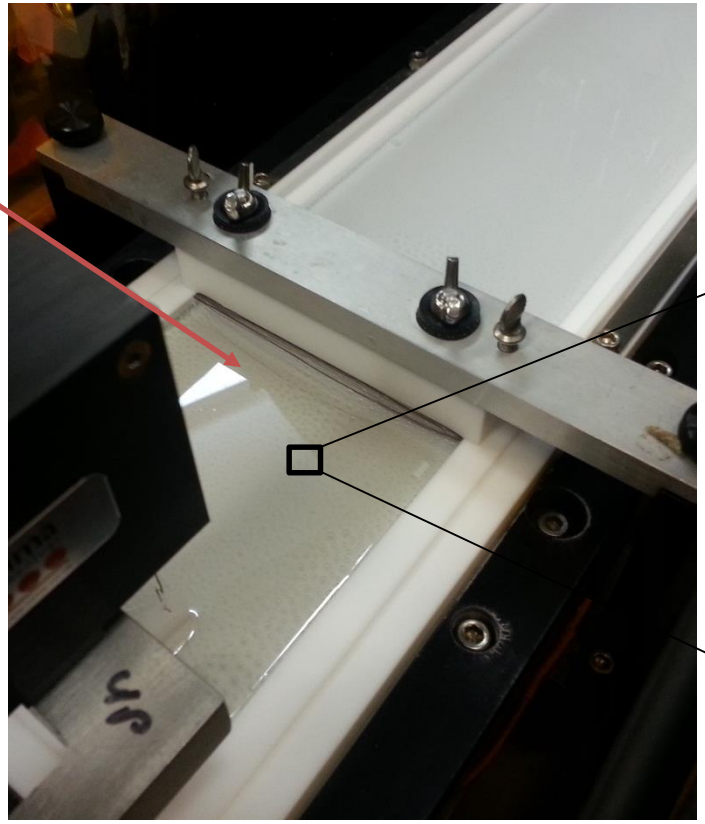


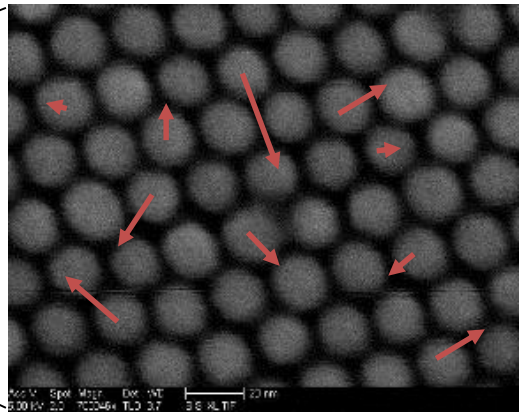


Barrier compression is *adiabatic*!

Conclusion







Viscoelastic system,
out-of-equilibrium
collective dynamics

Thank you!

Backup Slides

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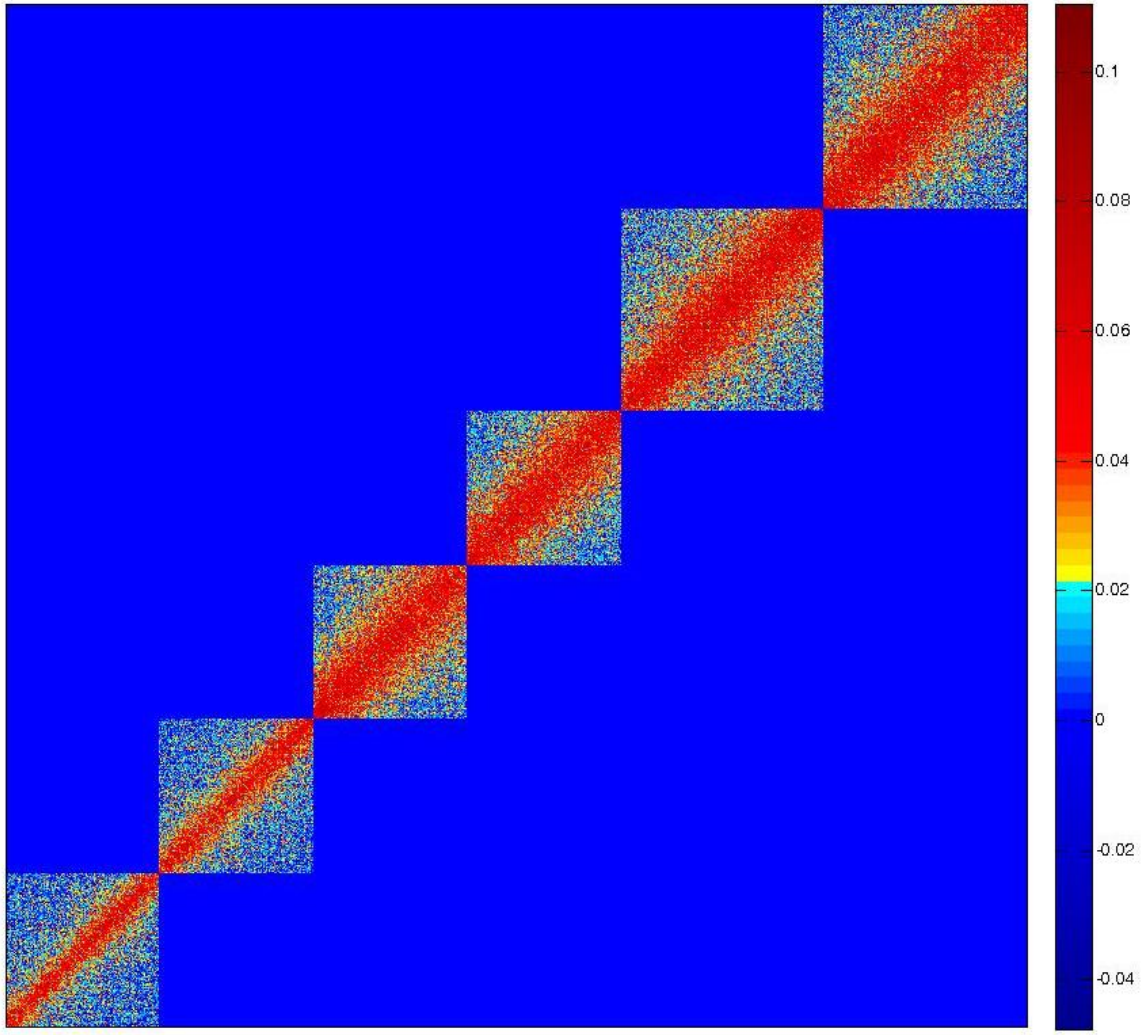
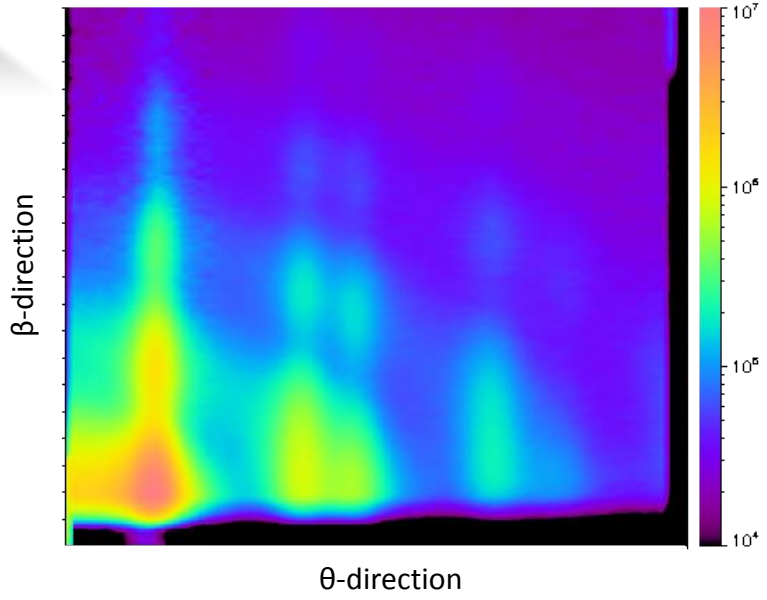
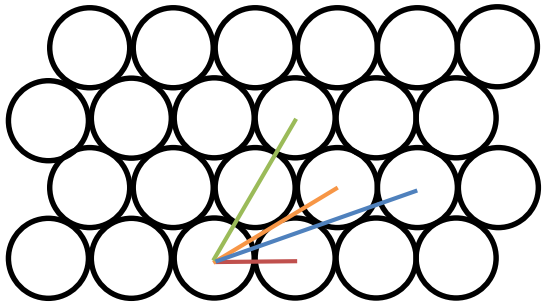
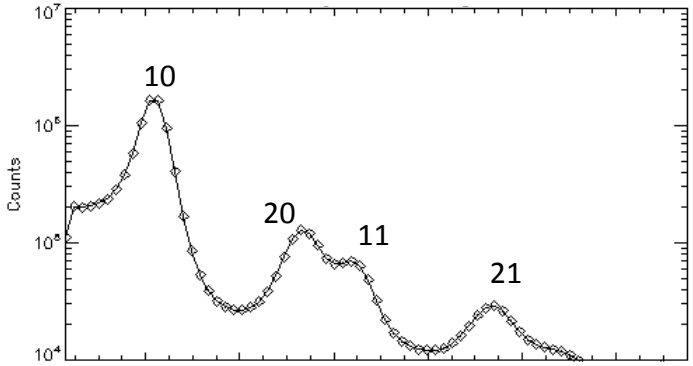
2-Time Correlation



In-Plane Film Structure







Nearest Neighbor Spacing

	1st	2nd	3rd	4th
Hexagonal Close Packed	1	$\sqrt{3}$ ≈1.73	2	$\sqrt{7}$ ≈2.65
Experiment	1	1.75	2.01	2.74